MONITORING SPECIES IN ARTIFICIAL REEFS USING ACOUSTIC COMMUNICATIONS

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Abstract- on this work, the performance, configuration and limitations in the field of an acoustic communication system to monitor marine species in artificial reefs has been studied and analyzed. The system described is composed by different hydrophones and acoustic transponders.

Keywords- hydrophones, acoustic communications, monitoring species, species tracking

I. INTRODUCTION

Advances on electronic technologies applied to marine applications have found new possibilities with the increasing offer of new miniaturized sensor and new types of wireless communications systems, which have opened a door to a new generation of distributed smart sensor networks, spatially or geographically disseminated in the environment. This is particularly interesting on these days, when 76 % of global fisheries stocks are currently over-exploited or exhausted and with risk of extinction if they are not managed correctly [1]. In order to help to prevent this, an adequate fishery management is imperative; therefore there is the need to increase the actual knowledge of the habits of the exploited species. This paper is a contribution to previous works [2-4] in which different technologies and designs were presented, developed, and tested to monitor and to study the behavior of species. These techniques were developed for their use in laboratories or small aquariums, and present many drawbacks when are used in the field. The strength of acoustic communications technology respect the previous works is the cost and maintenance of the system versus the detection area covered, this is shown in Table 1.

II. OBJECTIVES AND DESCRIPTION

The objective of this work is to study and analyze the performance and configurations of the hydrophones and the transmitters in artificial reefs, where interference problems are present due to the echoes of acoustic signals [5]. The results from this work will be used in a future experimental campaign with green shell crabs (Carcinus maenas), which has the purpose to investigate living habits.

The monitoring system is composed by three transmitters and four hydrophones, located inside and outside two artificial reefs, close to the OBSEA underwater observatory [6], which is located at a depth of 20m. The different experiments - location of the transmitters and hydrophones - make possible this study.

The underwater system is based on Vemco's commercial equipments. The transmitter is the model "V6", which operates at 180 kHz. This frequency operates well in both fresh and salt water, in a range of up to 200m. The most interesting features of these kinds of transmitters are their size and weight (6mm of diameter and a weight of 0.5 grams in water), in addition to the possibility to program the latency of the emitting signal, which can be from some seconds to minutes. This feature allows extending the active life of the transmitter when the experiment requires long periods of time (up to one year sending pings every several minutes). The hydrophones are the autonomous Vemco VR2W-180.

III. EXPERIMENTS AND RESULTS

The system described has a maximum detection range of 200 m. The location of transponders and hydrophones will influence this range as well as the presence of interferences in the medium. In our case, it will be severely affected by the signal reflections on the artificial reefs, which are concrete cubes of 2.5x2.5x2.5 m.

In order to test the system, a set of three transmitters and four hydrophones have been placed inside and outside the artificial reefs in two experiments, each with a particular function, as shown in the Figure 1.

On the first experiment, the detection range of transponder 2 is evaluated by hydrophones C and D. This set-up shows the high interferences caused by the artificial reef 1. In this case, C is able to detect sometimes the tag 2, meanwhile D is out of range. In this configuration, the mission of tag 3 is to check if hydrophones A, C and D are working well because all of them are inside the range. The location of tag 3 also permits to contrast the performance of detections

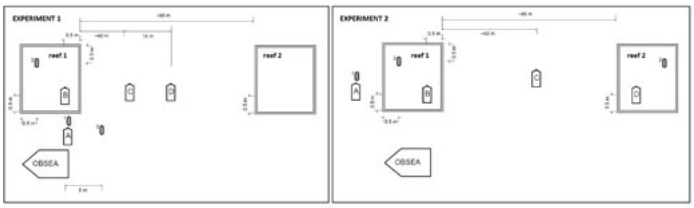

Fig. 1. Experiments performed

considering the interferences by the reef

On the second experiment, the distribution of some transmitters and hydrophones has changed. Here, receptions of hydrophones B and D is tested, in order to evaluate detections of the externals transmitters. On this case, Hydrophones A and C are used to contrast the detections from outside the reefs. The distance between reefs is enough to inhibit the acoustic signals from transmitters inside others reefs.

Results of different tests confirm also that the position of hydrophones inside closed areas is critical, and in order to improve the reception performance it is advisable to place them as far as possible of the reef walls. These results will be used on a experimental campaign for monitoring species in the OBSEA area.

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Features	IR barriers	RFID	Vision	Acoustic comm.
Transponder or ID attach to the specie	No	Yes	Yes	Yes
Cost Vs. detection area covered	Medium	Very High	Medium/high	Low
Maintenance	High	High	Medium/ low	Very low
Detection of multiple individuals	No	Yes	Yes	Yes
Transponder battery life	-	unlimited	-	limited
Detection highly affected by the environment	Yes	No	Yes	No

Table 1. Technologies comparison to monitor species